900933

INSTRUCTION AND MAINTENANCE MANUAL

SERIES 444

3 PHASE ZERO FIRED CONTROL

IMPORTANT:

READ ENTIRE MANUAL! FAILURE TO OBSERVE THE MECHANICAL AND ELECTRICAL CONSIDERATIONS DESCRIBED WITHIN MAY VOID THE WARRANTY!

WARNING:

DANGEROUS VOLTAGES WHICH CAN CAUSE SERIOUS INJURY OR BE FATAL EXIST WHENEVER POWER IS OR HAS BEEN APPLIED TO THE CONTROL! BE SURE TO READ ALL WARNINGS AND ALL PROCEDURES PRIOR TO DOING ANY START-UP, TROUBLESHOOTING OR ANY OTHER WORK INSIDE THE CONTROLLER.

BARBER COLMAN COMPANY

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Barber-Colman Company

INDUSTRIAL INSTRUMENTS DIVISION

1354 Clifford Avenue, Loves Park, Illinois, 61111

Phone 815-877-0241

Revised 10/86 - R. E. Kratovel

MP MASTER

MA32117

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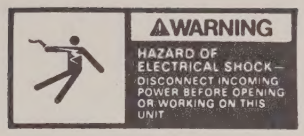


1.0 PART NUMBER AND GENERAL DRAWING NUMBERS

1.1 The units covered by this manual have part numbers of the form 444VWX.YZ. Table 1, page 10, defines the meanings and values for "V", "W", and "X". Table 2, page 11, defines the meanings and values (modifications) "Y" and "Z".

2.0 INTRODUCTION

2.1 The Series 444 SCR Power Controllers provide solid-state zero voltage gating time proportioning control of three phase AC power. The SCR's (thyristors) serve as a solid state "switch" which, when closed (at the instant of zero line voltage), applies full line voltage to the load.

2.2 Time proportioning is obtained by closing the "switch" (denoted "ON") for a certain number of half-cycles, and opening the "switch" (deonoted "OFF") for a second certain number of "ON" half-cycles of the AC supply. The ratio of the number of "ON" half-cycles to the total number of "ON" plus "OFF" half-cycles (denoted duty-cycle) is proportional to the average power delivered to a resistive load. The RMS value of the output voltage or current is approximately a linear function of the DC input control signal. Thus the duty-cycle is proportional to the square of the DC input control signal.

3.0 POWER REQUIREMENTS

3.1 Refer to nameplate or Table 1, page 10 for line voltage rating. Nominal value of line is + or -10%, three-phase, 50/60Hz. Standard ratings are nominal 208V, 240V, 380V, 415V, 480V and 600V.

4.0 LOAD RATINGS

4.1 RMS load voltage is controllable from zero to full line voltage (less approximately 1.5VAC SCR forward drop). The RMS value of the voltage output is approximately linear (within + or -2%) with average DC control over the range 20% to 95% output. The unit will maintain the RMS value of the output voltage within + or -1% at any setting between 20% and 90% voltage for a + or -10% variation in supply voltage.

4.2 Refer to nameplate or Table 1, page 10 for current rating. RMS load current rating is for continuous operation in free air at ambient temperatures of 50 degrees C (122 degrees F) or less. Typical momentary overload capability is 300% of RMS nameplate rating for 166 milliseconds.

4.3 These units must be operated into resistive loads drawing less than the rated nameplate current. The load resistance should be such that under conditions of maximum line voltage, the nameplate current rating is not exceeded.

4.4 The following types of loads cannot be used with these panels: transformer coupled loads, globars or molybdenum loads which require inrush current limiting and incandescent lamps or other fast response loads.

5.0 CONTROL REQUIREMENTS

5.1 The control signal to these units may be a DC milliampere control (e.g., from a temperature controller), a voltage control or a remote potentiometer.

5.2 The unit may be controlled with a remote manual potentiometer having any value betwen 1K and 5K ohms. See Diagram 1, page 14.

5.3 The unit may be controlled manually with the Gain potentiometer, P1. See Diagram 2, page 14.

5.4 The unit may be controlled by instruments delivering the following DC input signals: 5mA, 1-5mA, 2-12mA, 4-20mA or 10-50mA into various terminating impedances. See Diagram 4, page 14. Table 2, page 11 lists the appropriate shunt resistor R1 across terminals 6 and 7. The part number suffix "YZ" denotes the resistor that has been installed internally at the factory and its control current stage.

6.0 METERING

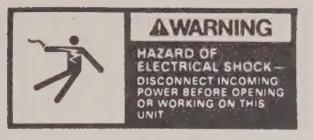
6.1 Damping or averaging is required in metering circuits to prevent conventional ammeters and voltmeters from following the ON-OFF action of the 444 series. To provide RMS sensing with the required damping, Robicon offers high accuracy auxiliary voltage and current converters for use only when metering is required. Refer to factory for addditional information on part numbers 359015 and 359016.

6.2 If an approximate (+ or -15%) indication of output voltage is desired for checking operation of a panel, the circuit given on Page 14 will provide this information.

7.0 INSTALLATION AND OPERATION

7.1 Installation Precautions

These air-cooled panels are rated for operation in ambients of 50 degrees C (122 degrees F) maximum. They should be mounted vertically in open air spaces. If the panels are mounted in spaces with restricted air flow, precautions should be taken to ensure a steady/state ambient of less than 50 degrees C.



7.2 Power Connections

For Series 444 units, connect the load to T1, T2, and T3. Connect the line to terminals A, B and C. PHASE SEQUENCE MUST BE POSITIVE (A,B,C) OR INTERNAL CIRCUITRY WILL NOT ALLOW UNIT TO OPERATE. If output is not obtained, reverse any TWO power connections. These units are designed for 3-wire operation. Do not use on 3-phase, 4-wire systems or parallel controllers for higher power.

7.3 Control Connections

7.31 Manual Control - Remote Potentiometer - See Diagram 3, Page 14. Connect the remote potentiometer as follows: Connect the clockwise end of the pot to terminal 2, the wiper to terminal 9, and the counterclockwise end to terminal 1. Clockwise rotation will increase output. The resistance of the pot can be anywhere between 1K ohms and 5K ohms.

7.32 Manual Control - P1 GAIN Potentiometer. See Diagram 6, Page 14. Connect terminals 2 and 8 together. Clockwise rotation of P1 GAIN potentiometer will increase output. Full output will be obtained at approximately 1/3 CW rotation.

7.33 Voltage Control - See Diagram 2, Page 14. Connect the positive end of a variable voltage source to terminal 9 and th negative end to terminal 1. The unit will accommodate sources from 0-7.5 through 0-90VDC. A jumper must be added between terminal 8 and 9 for full Gain control using a 0-3 to 0-45VDC voltage source. The input resistance varies between 3K and 10K (depending upon the setting of P1 GAIN pot).

7.34 Current Control - See Diagram 1, Page 14. Connect the positive end of a variable current source to terminal 7 and the negative end to terminal 6. A jumper must be added between terminals 7 and 8.

7.35 Interlock - If terminals 3 and 4 are connected together, no output will be obtained regardless of control input.

7.4 Operational Adjustments - Bias and Gain

IMPORTANT! DEVICE IS FACTORY CALIBRATED FOR GAIN AND BIAS SETTINGS. INSTRUCTIONS BELOW ARE GIVEN IF RECALIBRATION IS NECESSARY FOR TROUBLESHOOTING.

It will be necessary to monitor the output of the unit for the following adjustments. The output may be monitored with an appropriate AC voltmeter.

CAUTION: DO NOT SHORT ANY TERMINALS TOGETHER. DO NOT CONNECT <u>GROUNDED</u> INSTRUMENTS TO THESE TERMINALS.

If Robicon voltage or current metering converters have been ordered with the panel, these may be used also.

7.41 BIAS Adjustment - The bias pot is used for setting the off point. See Note 5, Page 14. Apply power to the unit. Remove the control signal from the unit or turn the manual pot full CCW. Turn the bias pot CW a little at a time until the output starts to operate in a pulsing fashion. Turn the bias pot CCW a little at a time until the output just remains full off. This may require minor adjustments for a minute or two until the electronics settle internally.

7.42 GAIN Adjustment - Now set the input control for the maximum control required. Turn the gain pot CW a little at a time until the output starts to operate in a pulsing fashion. Keep turning the gain pot CW (allowing time for the electronics to settle) until the output just remains full on. This may require minor adjustments for a minute or two.

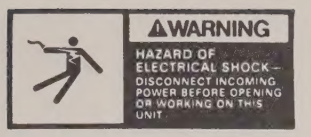
The above procedure is used for 0-5mADC, 0-3VDC, 0-16VDC control signals. For control signals of 6-9V, 2-1mADC, 4-20mADC, 10-50mADC, a slightly different adjustment is required.

SPECIAL NOTE: For 6-9V control, adjust the bias and gain as above for 0-3VDC. Then apply 9VDC to the input terminals and turn the bias CCW a little at a time until the output starts to turn off in a pulsing fashion. Then turn the bias pot slightly CW until the output just stays full on. It may be necessary to make minor adjustments for a minute or two until the electronics settle. The unit is now recalibratd for 6-9V control.

For 2-12mADC control, adjust the bias as in 7.41 above and adjust the gain pot for 0-10mADC at the input terminals. Then set 12mADC input and turn the bias CCW a little at a time until the output starts to operate in a pulsing fashion. Turn the bias CW a little at a time until the output does not pulse but stays full on for a minute or two. The unit is now recalibrated for 2-12mADC control.

For 4-20mADC control, adjust the bias as in 7.41 above but adjust the gain pot for 0-16mA control input and adjust input for 20mADC control.

The procedure is exactly the same for 10-50mADC control. Adjust the gain pot for 0-40mA and adjust the bias for 50mA.



8.0 MAINTENANCE

8.1 Periodic Inspection

8.11 It is important that the unit be kept clean. A layer of dust or process waste will reduce the heat transferring properties of the heat sinks. It is recommended that the dust be blown off periodically.

8.12 All units subjected to corrosive atmospheres should have the electrical connections periodically inspected. Tarnished connections should be cleaned and joint compound applied. Alcoa No. 2 Joint Compound is recommended for field applications. See the manufacturer's instructions on the can for joint preparation.

8.2 Component Replacement. If any electrical components are unfastened during inspection or during troubleshooting, prepare the surfaces as follows: All fuse ends with connections should be cleaned according to the instructions with Alcoa No. 2 Joint Compound before the compound is applied. SCR's should be treated with Wakefield #120 Thermal Joint Compound according to the manufacturer's instructions (sparingly). Alcoa No. 2 joint compound is also recommended for SCR mounting.

9.0 TROUBLESHOOTING

The following checks can be made with a multimeter. Replacement of SCR's can be made in the field, but if the trouble is ascribed to the control board, the unit must be returned to the factory. Refer to Section 8.2 before replacing any SCR's.

CAUTION: THE VOLTAGES PRESENT ON THESE UNITS ARE DANGEROUS. MAKE SURE THE POWER IS OFF WHILE SERVICING.

CAUTION: DO NOT REPLACE SCR'S OR RECTIFIERS WITHOUT TORQUE AND REMOUNTING INSTRUCTIONS FROM FACTORY.

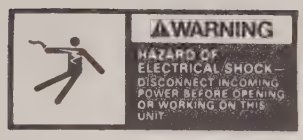
9.1 Symptom: No output voltage or current.

Probable Cause: No input, incorrect phase sequence, or loss of one phase.

Remedy: The line to line voltages should be within 20% of each other. Measure with AC voltmeter. If the voltages are balanced, reverse any TWO input leads.

Probable Cause: Blown fuse.

	Remedy:	Open power to controller. Disconnect one end of fuse and check resistance with ohmmeter. It should measure less than 1 ohm. Replace, if necessary, with SAME type. DO NOT INSTALL ANY OTHER TYPE OF FUSE. Measure load resistance and make sure that panel is not being used beyond its rated current. Check for high input voltage.
	Probable Cause:	Incorrect bias setting or input signal.
	Remedy:	Check settings as per Section 7.4 and readjust, if necessary.
	Probable Cause:	Incorrect wiring of external circuit.
	Remedy:	Check for proper load and control connections.
9.2	Symptom:	Low power output.
	Probable Cause:	One leg of load is open.
	Remedy:	Repair open element.
9.3	Symptom:	Full output on all phases.
	Probable Cause:	Bias, Gain or input signal too high.
	Remedy:	Check settings as per Section 7.4 and readjust if necessary. Refer to Figures 3-5 (Pages 11, 12). If turning gain control to max. CCW position does not cause output to decrease, bias is too high. With input signal disconnected, turning bias control CCW should cause output to decrease.
9.4	Symptom:	Full output on one or all phases.
	Probable Cause:	Malfunctioning SCR's.
	Remedy:	Disconnect the two leads of a suspected SCR. The heavy gauge lead is the cathode or A1, the lighter gauge lead is the gate and the case is the anode or A2. Check the resistance readings for conformity to the following table:



SCR's

Anode	Cathode	Gate	Ohmmeter Reading
Open	Neg.	Pos.	5 to 100 ohms
Open	Pos.	Neg.	40 ohms or greater
Pos.	Neg.	Open	1 megohm or greater
Neg.	Pos.	Open	1 megohm or greater
Pos.	Both negative		1 megohm or greater
Neg.	Both positive		1 megohm or greater

Because of manufacturing differences, an SCR not conforming to this table may be good and an SCR conforming may be defective. In the latter case, the SCR could be breaking down (shorting) when exposed to rated voltage. The only way to test for this in the field is to substitute an SCR known to be good. If the symptoms are cleared, the replaced thyristor was defective.

9.5 Symptom: Output non-linear.

Probable Cause: Improper operation of control circuitry on P.W. board.

Remedy: Assuming the output of the unit can be controlled from full off to full on, proceed as follows:

9.51 Monitor the panel output with either a Robicon converter or build the circuit described on Page 12 of this manual. This circuit provides indication only and is not intended to be accurate.

9.52 Monitor the control input using a voltmeter for voltage control, a milliammeter for current control or a calibrated potentiometer for manual control as required.

9.53 Set the bias and gain controls as previously described in Section 7.4.

9.54 Adjust control to 100% (full output). Converters should read 100% current or voltage as determined by load and input voltage. The test circuit should read within the outside limits shown on the graph on Page 14.

9.55 Check for conformity to the graph at various control inputs between full on and full off. If the converters are used, the control-output relationship will be linear; i.e., 50% output will correspond to 50% control input, etc.

9.56 If unit does not conform, do not attempt to repair P.W. board. Return unit to factory.

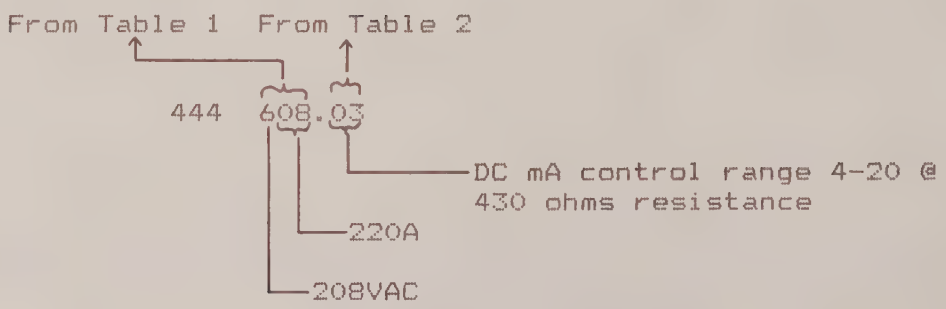
TABLE 1

PART NUMBER DEFINITIONS

444VWX.YZ

"V" Nominal Line Voltage 3 Phase		"WX" Rated RMS Current		
0	Special	02	25A	
2	240VAC	03	50A	
3	480VAC	04	75A	Convection
5	600VAC	05	100A	Cooled
6	208VAC	07	160A	
8	415VAC	08	220A	
7	380VAC	10	310A	
		11	400A	
		12	550A	

PART NUMBER EXAMPLE



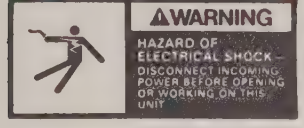


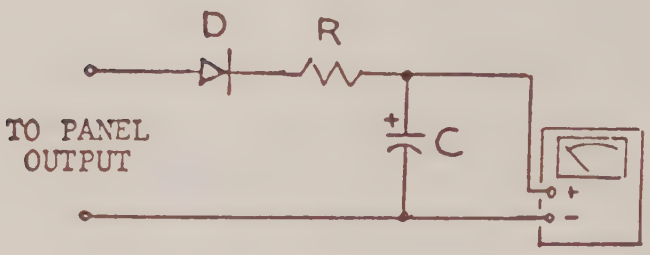
TABLE 2

"YZ" DASH NUMBER MODIFICATION

DC MILLIAMPERE CONTROL

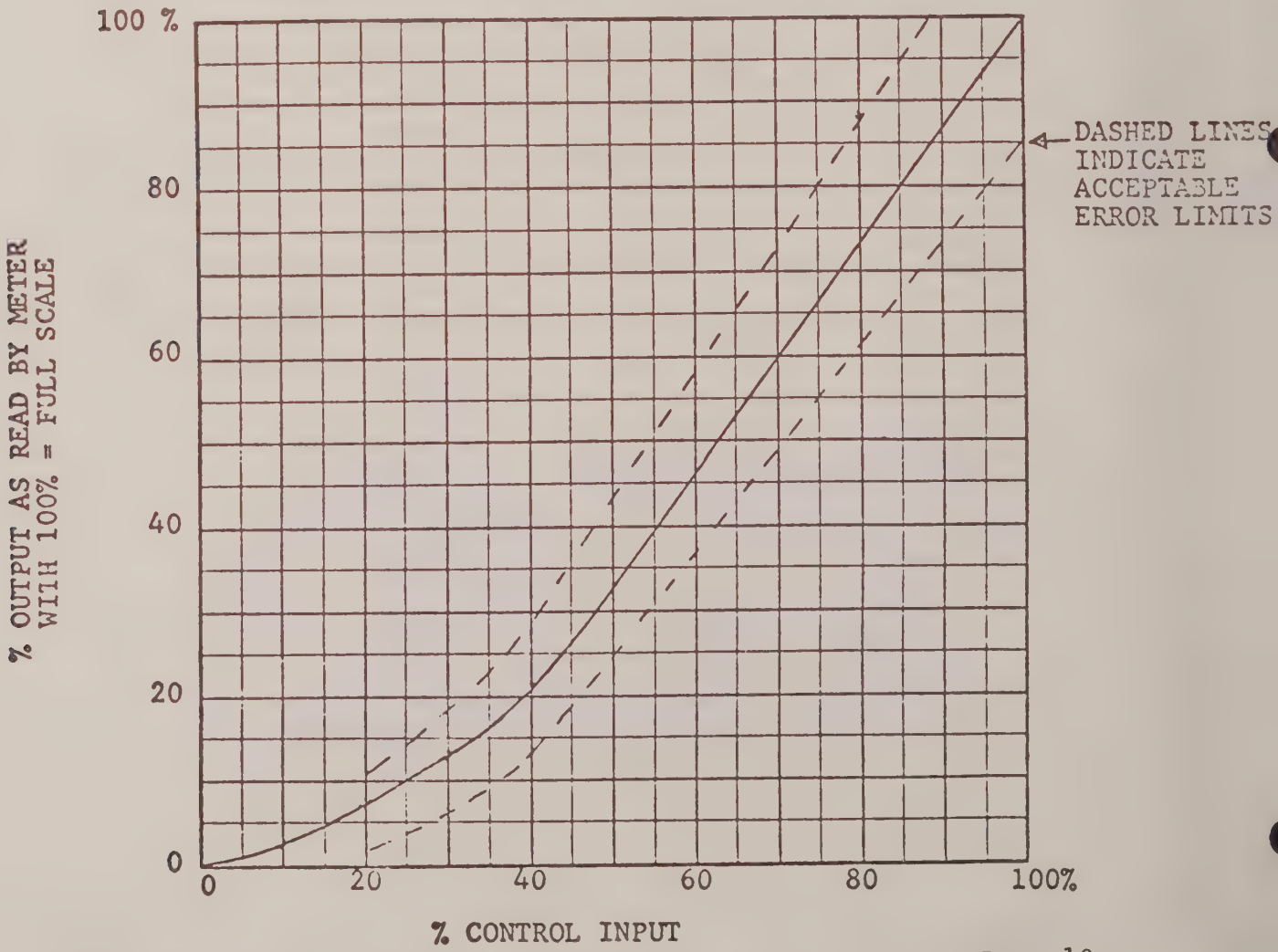
PART NUMBER SUFFIX	NOMINAL INPUT RESISTANCE (OHMS)	NOMINAL RANGE (MA)	INPUT MATCHING RESISTOR (R9) ACROSS TERMINALS 6-7 (OHMS) (1/2W UNLESS OTHERWISE NOTED)
STD	3.33K-5K		NO RESISTOR
.01	230	4-20	240
.02	340	4-20	360
.03	430	4-20	470
.04	600	10-50	680, 2W
.05	770	4-20	910
.06	970	0-5	1200
.07	1150	4-20	1500
.08	1430	0-5	2000
.09	1430	2-12	2000
.10	2000	0-5	3300
.11	2800	1-5	6800
.12	4000	-5	20K
.13	4000	-7	20K
.14	5000	1-5	NO RESISTOR
.15	10K	1-5	NO RESISTOR
.16	1430	1-5	2000
.17	970	12-20	1200
.18	430	0-20	470
.19	3.3K-5K	6-9VDC	NO RESISTOR

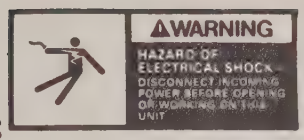
MEDIUM ACCURACY TEST CIRCUIT



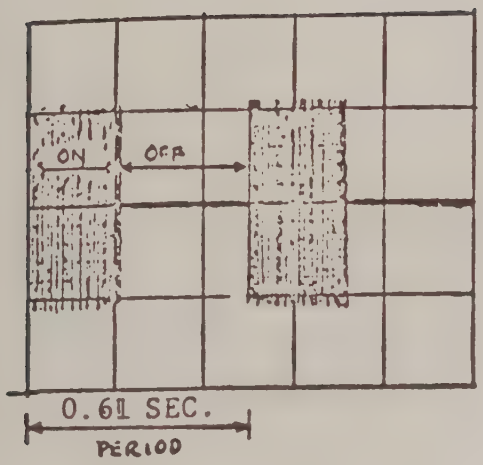
20KΩ/V
MULTIMETER
E.G., SIMPSON 260.

VOLTAGE RATING	RESISTOR R (OHM)	CAPACITOR C (POLAR)	DIODE (OR EQUIV.)	SET METER RANGE TO
480 V	3.9 MEG	3MFD/50V	1N4006, 1N5053	50V DC
240 V	2.0 MEG	3MFD/50V	1N4004, 1N4820	50V DC
208 V	1.8 MEG	3MFD/50V	1N4004, 1N4820	50V DC

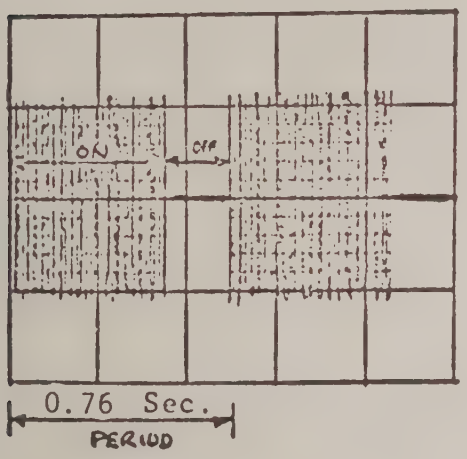




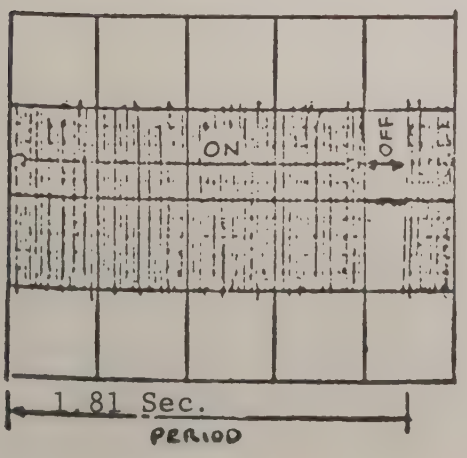
TYPICAL OSCILLOSCOPE TRACES
SERIES 444 TIME PROPORTIONING CONTROLLERS



70% Control
Period = 0.61 Sec.
On Time = 0.28 Sec.
Off Time = .325 Sec.
Ratio of on time to Period = .459



84 % Control
Period = 0.76 Sec.
On Time = 0.5 Sec.
Off Time = 0.26 Sec.
Ratio of on time to Period = .658



95 % Control
Period = 1.81 Sec.
On Time = 1.6 Sec.
Off Time = 0.21 Sec.
Ratio of on Time to Period = .884

NOTES:

1. GENERAL:

THE THREE PHASE, SOLID STATE ELECTRIC HEAT CONTROLLERS DESCRIBED ON THIS DRAWING ARE OF THE FOUR THYRISTOR (SCR)TYPE. THESE UNITS ARE ZERO VOLTAGE FIRED AND UTILIZE TIME PROPORTIONING OF OUTPUT FOR CONTROL. THIS MEANS THAT OUTPUT OCCURS IN "BURSTS" OF FULL HALF CYCLES OF THE A.C.SUPPLY AND THAT CONTROL IS OBTAINED BY MODULATING THE LENGTH OF BOTH THE BURSTS OF OUTPUT AND THE OFF TIMES. THE ZERO VOLTAGE FIRING MINIMIZES HIGH FREQUENCY ELECTRONIC NOISE SOMETIMES ASSOCIATED WITH THYRISTOR CONTROLS. THE THYRISTOR CONTROLLER IS CONNECTED TO THE THREE WIRE, THREE PHASE LOAD AS SHOWN IN FIGURE 1 (ON SHEET 2). LOADS SHOWN ARE CONNECTED IN DELTA, BUT A WYE CONNECTION MAY ALSO BE USED AS LONG AS THE NEUTRAL IS NOT RETURNED TO THE SUPPLY.

2. POWER CONNECTIONS:

INPUT POWER IS CONNECTED AT TERMINALS A,B,C. CHECK INFORMATION IN TABLE 1 FOR VOLTAGE AND CURRENT RATINGS AND TERMINAL LUG INFORMATION. PHASE SEQUENCE MUST BE A-B-C.

CAUTION NOTE:

THESE UNITS ARE PHASE SEQUENCE SENSITIVE. THE GATE TRIGGER CIRCUITRY HAS BEEN DESIGNED TO INHIBIT OUTPUT IF PHASE SEQUENCE IS IMPROPER. IF NO OUTPUT IS OBTAINED AFTER INITIAL HOOKUP, REVERSE ANY TWO INPUT CONNECTIONS.

LOAD IS CONNECTED TO TERMINALS T1,T2,T3.

3. CONTROL CONNECTIONS:

THE CONTROL SIGNAL TO THESE UNITS MAY BE A DC MILLIAMPERE CONTROL (E.G. FROM A TEMPERATURE CONTROLLER), A VOLTAGE CONTROL, OR A REMOTE POTENTIOMETER.

A. DC MILLIAMPERE CONTROL
SEE DIAGRAM 1 FOR WIRING CONNECTIONS. CONNECT POSITIVE SIDE OF VARIABLE CURRENT SOURCE TO CUSTOMER TERMINAL 7, NEGATIVE SIDE TO CUSTOMER TERMINAL 1 (OR 6); AND JUMPER CUSTOMER TERMINALS 7 AND 8 TOGETHER. SEE TABLE 2 FOR AVAILABLE CURRENT RANGES AND INPUT RESISTANCES. MINIMUM DC MILLAMPERE CURRENT (I_C MIN) FOR OUTPUT (MAX. GAIN: P1 FULL CW) MUST SATISFY THE FOLLOWING RELATION:

$$\frac{R_I \times 3K}{R_I + 3K} (I_C \text{ MIN.}) = .3 \text{ VOLTS}$$

WHERE R_I IS SELECTED TO MATCH THE LOADING REQUIREMENT OF THE INSTRUMENT (MILLIAMPERE SOURCE). MAXIMUM MA CONTROL CURRENT MUST NOT EXCEED POWER RATING OF RESISTOR R_I (½W) OR GAIN POT P1 (2W). R_I IS 2W FOR A 10-50 MA CONTROL.

B. VOLTAGE CONTROL:
SEE DIAGRAM 2 FOR WIRING CONNECTIONS. CONNECT POSITIVE SIDE OF VARIABLE SOURCE TO CUSTOMER TERMINAL 9, NEGATIVE SIDE TO CUSTOMER TERMINAL 1 (OR 6). VOLTAGE RANGE FROM 0-45 VDC TO 0-90 VDC AT 8.33K MINIMUM INPUT RESISTANCE.

NOTE: FOR 0-3 VDC (MAX. GAIN) TO 0-45 VDC AT 3.33K MINIMUM INPUT RESISTANCE, JUMPER CUSTOMER TERMINALS 8 AND 9 TOGETHER.

C. MANUAL CONTROL: REMOTE POTENTIOMETER:
SEE DIAGRAM 3 FOR WIRING CONNECTIONS. CONNECT THE CW TERMINAL OF THE REMOTE POTENTIOMETER TO CUSTOMER TERMINAL 2, CCW TERMINAL TO TERMINAL 1 (OR 6), AND THE WIPER TO TERMINAL 9. THE POTENTIOMETER MAY HAVE ANY VALUE BETWEEN 1K AND 5K OHMS (1K RECOMMENDED).

D. MANUAL CONTROL: USING GAIN POTENTIOMETER:
CONNECT CUSTOMER TERMINALS 2 AND 9 TOGETHER (ALL OTHER TERMINALS DISCONNECTED AND UNJUMPERED). FULL OUTPUT WILL BE OBTAINED NEAR THE FULL CW POSITION OF THE GAIN POT.

E. INTERLOCK:
IF CUSTOMER TERMINALS 3 AND 4 ARE CONNECTED TOGETHER, NO OUTPUT WILL BE OBTAINED, REGARDLESS OF CONTROL INPUT.

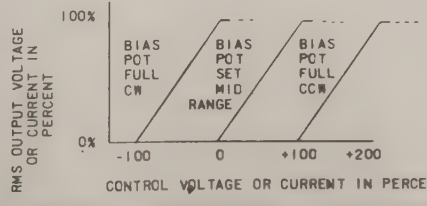
F. SOLID STATE CONTACTOR CONNECTION SEE DIAGRAM 4.

4. DIELECTRIC TEST VOLTAGES:

LINE VOLTAGE OF UNIT	208 VAC MIN.	240 VAC MIN.	480 VAC MIN.	6000 VAC MIN.
CONTR. CKT. TO GND.	1000 VAC MIN.	1000 VAC MIN.	1000 VAC MIN.	1000 VAC MIN.
PWR. CKT. TO CONTR. CKT.	1500 VAC MIN.	1500 VAC MIN.	2000 VAC MIN.	2200 VAC MIN.
PWR. CKT. TO GND.	1500 VAC MIN.	1500 VAC MIN.	2000 VAC MIN.	2200 VAC MIN.

5. GAIN AND BIAS CONTROLS:
GAIN: A MINIMUM CONTROL VOLTAGE (OR THE VOLTAGE DEVELOPED BY THE DC MILLIAMPERE CONTROL CURRENT THROUGH THE PARALLEL RESISTOR COMBINATION OF THE INPUT MATCHING RESISTOR R_I AND THE GAIN POT P1 NETWORK) OF 3 VOLTS IS NECESSARY FOR FULL OUTPUT (MAX. GAIN: P1 FULL CW AND TERMINALS 8 AND 9 JUMPERED). THE GAIN POT HAS SATISFACTORY RESOLUTION FOR A CONTROL VOLTAGE (OR MA CURRENT 15 TIMES GREATER THAN THE STATED MINIMUM.)

BIAS: THE BIAS CONTROL IS FACTORY SET TO PROVIDE 0 OUTPUT FOR 0 DC CONTROL. HOWEVER, OFF SET CAN BE PROVIDED SHOWN BELOW:



6. OPERATION:

THESE UNITS PROVIDE TIME PR
WITH ZERO VOLTAGE FIRING OF
RESISTANCE LOADS WHICH WILL
IT WILL NOT OPERATE INTO TR

AT NOMINAL GAIN SETTINGS TH
IS A LINEAR FUNCTION OF THE
REGULATING FOR VARIATIONS I
CHANGE IN AC SUPPLY VOLTAGE
VOLTAGE WILL VARY LESS THAN
OPERATING RANGE.

7. INSTALLATION

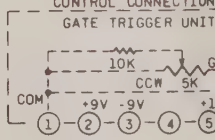
MOUNTING: UNITS SHOULD BE
1, 2, 3, 4, 5.
FLOW THROUGH THE

POWER REQUIREMENTS: MAXIMU
TABLE
CONTRO
INDIVI
TEMPER

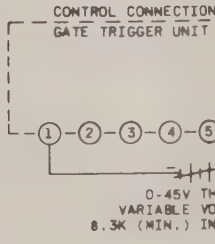
CAUTION NOTE CAUTION DO

8. SEE INSTRUCTION MANUAL 900
AIDS, AND PARTS LAYOUTS.

DIAG



DIAG



COMP SHEET 2
SHEET NO 1
DWG NO 444 300
REV A

REVISIONS
REV TITLE
A

ORTIONING CONTROL OF OUTPUT LOAD VOLTAGE
HE SCR'S. IT IS SUITABLE FOR USE WITH
RAW LESS THAN RATED CURRENT (SEE TABLE 1.)
SFORMER COUPLED OR INDUCTIVE LOADS.

EFFECTIVE (RMS) VALUE OF OUTPUT VOLTAGE
NPUT DC COMMAND SIGNAL AND IT IS SELF-
AC SUPPLY VOLTAGE: E.G. WITH A ±10%
THE EFFECTIVE RMS VALUE OF OUTPUT
1% OF FULL SCALE WITHIN THE LINEAR

IENTED FOR MOUNTING AS SHOWN IN FIGURES
ERE SHOULD BE NO RESTRICTION OF AIR
NIT.

THREE PHASE LOADS IN KW ARE SHOWN IN
NOTE: THAT THE OUTPUT OF EACH
ER MUST BE CONNECTED TO ITS OWN
AL LOAD. RATINGS APPLY FOR AMBIENT
URES LESS THAN 120°F

OT PARALLEL CONTROLLER OUTPUTS.

3 FOR ADDITIONAL DETAILS, TROUBLE SHOOTING

AM 1

- DC MILLIAMPERE
CIRCUIT BOARD

IN
CW R9 5.1K
V
TEST
6 7 8 9 10
I_C
FOR MA CONTROL
ONLY. (SEE NOTE 3A)

AM 2

- DC VOLTAGE
IRCUIT BOARD

6 7 8 9 10
FOR 0-3V
THRU 0-45V
(SEE NOTE 3B)
U 0-90V
TAGE SOURCE
UT RESISTANCE

DIAGRAM 3

CONTROL CONNECTIONS - MANUAL

GATE TRIGGER UNIT CIRCUIT BOARD

1 2 3 4 5 6 7 8 9 10

CCW
0%

CW
100%

1K TO 5K
MANUAL CONTROL POT

DIAGRAM 4

SOLID STATE CONTACTOR CONNECTION

GATE TRIGGER UNIT CIRCUIT BOARD

1 2 3 4 5 6 7 8 9 10

N.O. CONTACTS

GAIN-FULL CLOCKWISE
BIAS-1/4 TURN PAST CENTER
TOWARD CCW END OF THE POT

DIAGRAM 5

CONTROL CONNECTIONS - MANUAL - 135Ω POT

1 2 3 4 5 6 7 8 9 10

550Ω, 3W

CCW CW

135Ω
MANUAL CONTROL POT

DIAGRAM 6

CONTROL CONNECTIONS - MANUAL

GATE TRIGGER UNIT CIRCUIT BOARD

1 2 3 4 5 6 7 8 9 10

MANUAL CONTROL USING P1 GAIN POT.
FULL OUTPUT WILL BE OBTAINED AT
APPROXIMATELY 1/3 CW ROTATION
(FROM FULL CCW POSITION)

SCALE NONE	COLMAN	TITLE ZERO FIRED CONTROL NOTES	
DATE 6/15/83	Robicon Corporation		
DRAWN AB	A BARBER-COLMAN COMPANY	DWG NO 444 300	REVISION A
REVIEW	CUSTOMER 444 STD	CONT. ON SHEET 2	SHEET NO. 1
CHECK	WORK ORDER	NO OF SHEETS 6	
APPROVED			

TABLE 1

ROBICON PART NO.	VOLTS	AMPS	OUTLINE FIGURE	PRESSURE LUG POWER TERMINALS A. B. C. T1, T2, T3	REPLACEMENT PARTS SCR1-4	SCR MFGR.	FUSE F1-F3	FUSE MFGR.	ROBICON SUPP1-3	GTU-GATE TRIGGER UNIT ASSEMBLY
444602	208	25	1	#14-12AWG	261029.28	ROBICON	KAC30	BUSS	168100.06	464723.01
444603	208	50	2	#18-4AWG	261029.16	ROBICON	A25X60-4	GOULD-SH	168100.06	464723.01
444604	208	75	3	#18-4AWG	261029.22	ROBICON	A25X100-4	GOULD-SH	168100.06	464723.01
444605	208	100	4	#12-1/0	261029.22	ROBICON	A25X150-4	GOULD-SH	168100.06	464723.01
444607	208	160	5	250MCM-6	261056.03	ROBICON	A25X200-4	GOULD-SH	168100.06	464723.01
444608	208	220	5	250MCM-6	261056.21	ROBICON	A25X250-4	GOULD-SH	168100.06	464723.01
444610	208	310	6	350MCM-6	261056.21	ROBICON	A25X350-4	GOULD-SH	168100.06	464723.01
444611	208	400	6	600MCM-4/0	261057.29	ROBICON	A25X500-4	GOULD-SH	168100.06	464723.01
444612	208	550	6	1000-500MCM	C450E-1	GE	A25X600-4	GOULD-SH	168100.06	464723.01
444202	240	25	1	#14-12AWG	261029.28	ROBICON	KAC30	BUSS	168100.06	464723.02
444203	240	50	2	#18-4AWG	261029.16	ROBICON	A25X60-4	GOULD-SH	168100.06	464723.02
444204	240	75	3	#18-4AWG	261029.22	ROBICON	A25X100-4	GOULD-SH	168100.06	464723.02
444205	240	100	4	#12-1/0	261029.22	ROBICON	A25X150-4	GOULD-SH	168100.06	464723.02
444207	240	160	5	250MCM-6	261056.03	ROBICON	A25X200-4	GOULD-SH	168100.06	464723.02
444208	240	220	5	250MCM-6	261056.21	ROBICON	A25X250-4	GOULD-SH	168100.06	464723.02
444210	240	310	6	350MCM-6	261056.21	ROBICON	A25X350-4	GOULD-SH	168100.06	464723.02
444211	240	400	6	600MCM-4/0	261057.29	ROBICON	A25X500-4	GOULD-SH	168100.06	464723.02
444212	240	550	6	1000-500MCM	C450E-1	GE	A25X600-4	GOULD-SH	168100.06	464723.02
444702	380	25	1	#14-12AWG	261029.29	ROBICON	KAC30	BUSS	168100.07	464723.03
444703	380	50	2	#18-4AWG	261029.17	ROBICON	A50P60-4	GOULD-SH	168100.07	464723.03
444704	380	75	3	#18-4AWG	261029.23	ROBICON	A50P100-4	GOULD-SH	168100.07	464723.03
444705	380	100	4	#12-1/0	261029.23	ROBICON	A50P125-4	GOULD-SH	168100.07	464723.03
444707	380	160	5	250MCM-6	261056.06	ROBICON	A50P200-4	GOULD-SH	168100.07	464723.03
444708	380	220	5	250MCM-6	261056.24	ROBICON	A50P250-4	GOULD-SH	168100.07	464723.03
444710	380	310	6	350MCM-6	261056.24	ROBICON	A50P350-4	GOULD-SH	168100.07	464723.03
444711	380	400	6	600MCM-4/0	261057.32	ROBICON	A50P500-4	GOULD-SH	168100.07	464723.03
444712	380	550	6	1000-500MCM	261058.25	ROBICON	A50P600-4	GOULD-SH	168100.07	464723.03
444802	415	25	1	#14-12AWG	261029.29	ROBICON	KAC30	BUSS	168100.07	464723.04
444803	415	50	2	#18-4AWG	261029.17	ROBICON	A50P60-4	GOULD-SH	168100.07	464723.04
444804	415	75	3	#18-4AWG	261029.23	ROBICON	A50P100-4	GOULD-SH	168100.07	464723.04
444805	415	100	4	#12-1/0	261029.23	ROBICON	A50P125-4	GOULD-SH	168100.07	464723.04
444807	415	160	5	250MCM-6	261056.06	ROBICON	A50P200-4	GOULD-SH	168100.07	464723.04
444808	415	220	5	250MCM-6	261056.24	ROBICON	A50P250-4	GOULD-SH	168100.07	464723.04
444810	415	310	6	350MCM-6	261056.24	ROBICON	A50P350-4	GOULD-SH	168100.07	464723.04
444811	415	400	6	600MCM-4/0	261057.32	ROBICON	A50P500-4	GOULD-SH	168100.07	464723.04
444812	415	550	6	1000-500MCM	261058.25	ROBICON	A50P600-4	GOULD-SH	168100.07	464723.04
444302	480	25	1	#14-12AWG	261029.29	ROBICON	KAC30	BUSS	168100.07	464723.05
444303	480	50	2	#18-4AWG	261029.17	ROBICON	A50P60-4	GOULD-SH	168100.07	464723.05
444304	480	75	3	#18-4AWG	261029.23	ROBICON	A50P100-4	GOULD-SH	168100.07	464723.05
444305	480	100	4	#12-1/0	261029.23	ROBICON	A50P125-4	GOULD-SH	168100.07	464723.05
444307	480	160	5	250MCM-6	261056.06	ROBICON	A50P200-4	GOULD-SH	168100.07	464723.05
444308	480	220	5	250MCM-6	261056.24	ROBICON	A50P250-4	GOULD-SH	168100.07	464723.05
444310	480	310	6	350MCM-6	261056.24	ROBICON	A50P350-4	GOULD-SH	168100.07	464723.05
444311	480	400	6	600MCM-4/0	261057.32	ROBICON	A50P500-4	GOULD-SH	168100.07	464723.05
444312	480	550	6	1000-500MCM	261058.25	ROBICON	A50P600-4	GOULD-SH	168100.07	464723.05
444502	600	25	1	#14-12AWG	261029.30	ROBICON	KAC30	BUSS	168100.07	464723.06
444503	600	50	2	#18-4AWG	261029.18	ROBICON	A70P60-4	GOULD-SH	168100.07	464723.06
444504	600	75	3	#18-4AWG	261029.24	ROBICON	A70P100-4	GOULD-SH	168100.07	464723.06
444505	600	100	4	#12-1/0	261029.24	ROBICON	A70P125-4	GOULD-SH	168100.07	464723.06
444507	600	160	5	250MCM-6	261056.07	ROBICON	A70P200-4	GOULD-SH	168100.07	464723.06
444508	600	220	5	250MCM-6	261056.25	ROBICON	A70P250-4	GOULD-SH	168100.07	464723.06
444510	600	310	6	350MCM-6	261056.25	ROBICON	A70P350-4	GOULD-SH	168100.07	464723.06
444511	600	400	6	600MCM-4/0	261057.33	ROBICON	A70P500-4	GOULD-SH	168100.07	464723.06
444512	600	550	6	1000-500MCM	261058.26	ROBICON	A70P600-4	GOULD-SH	168100.07	464723.06

CONT. SHEET 3
SHEET NO. 2
DWG. NO. 444300
REV. A

BTG. ORD. NO. 1194M

REVISIONS	
A	REV. 400A SCR P/N'S WERE 261057.16 261057.19 261057.20 NGJ 3/84

TABLE 2

PART NUMBER SUFFIX	DC MILLIAMPERE CONTROL		
	NOMINAL INPUT RESISTANCE (OHMS)	NOMINAL RANGE (MA)	INPUT MATCHING RES. R9(OHMS) ACROSS TERMS. 6&7. 1/2W CARB. UNLESS OTHERWISE NOTED
.00	3.33K-5K		NO RESISTOR
.01	230	4-20	240
.02	340	4-20	360
.03	430	4-20	470
.04	600	10-50	680 2W
.05	770	4-20	910
.06	970	0-5	1200
.07	1150	4-20	1500
.08	1430	0-5	2000
.09	1430	2-12	2000
.10	2000	0-5	3300
.11	2800	1-5	6800
.12	4000	-5	20K
.13	4000	-7	20K
.14	5000	1-5	NO RESISTOR
.15	10K	1-5	NO RESISTOR
.16	1430	1-5	2000
.17	970	12-20	1200
.18	430	0-20	470
.19	3.3K-5K	6-9VDC	NO RESISTOR

NOTE: OTHER PART NUMBER SUFFIX DESCRIPTIONS.

1. FOR 3RD LINE FUSE ADD 20 TO P/N SUFFIX IN TABLE
   2. I.E. .00 BECOMES .20 WHEN 3RD LINE FUSE IS USED.

SCALE	NTS	ROBICON CORPORATION A BARBER-COLMAN COMPANY 100 Ingomar Hill Road, Pittsburgh, PA 15239	TITLE REPLACEMENT PARTS & P/N SUFFIX DESC. FOR ZERO FIRED CONTROL
DATE	08/13/83		
DRAWN	MGJ		
REVIEW	RCR		DWG. NO. 444300 REVISION A
CHECK		CUSTOMER	
APPROVE	RCB	WORK ORDER / NO. OF SHEETS 6	CONT. ON SHEET 3 / SHEET NO. 2

FIG. 1
25 AMPS

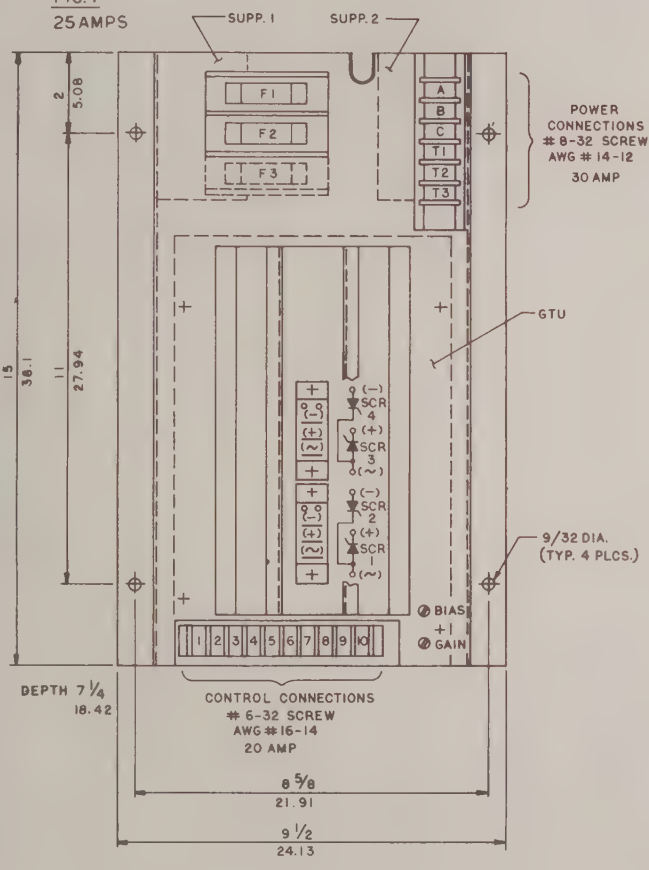
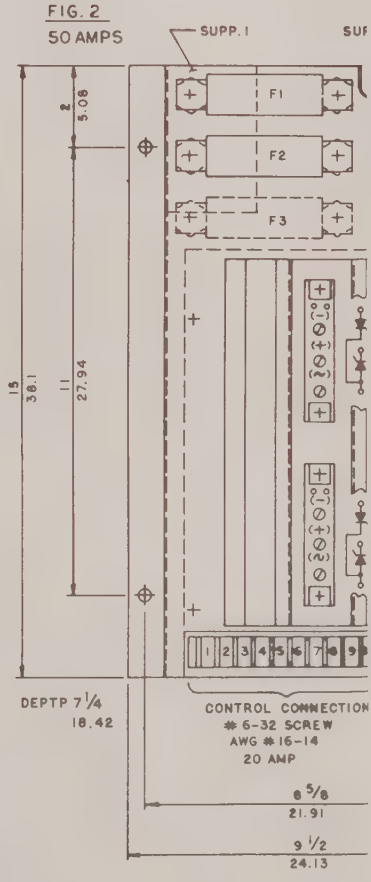


FIG. 2
50 AMPS

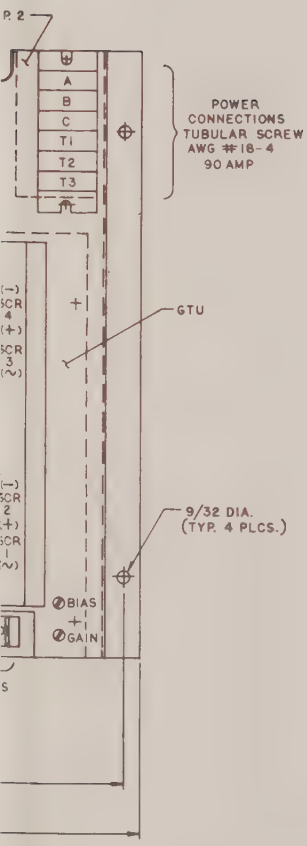


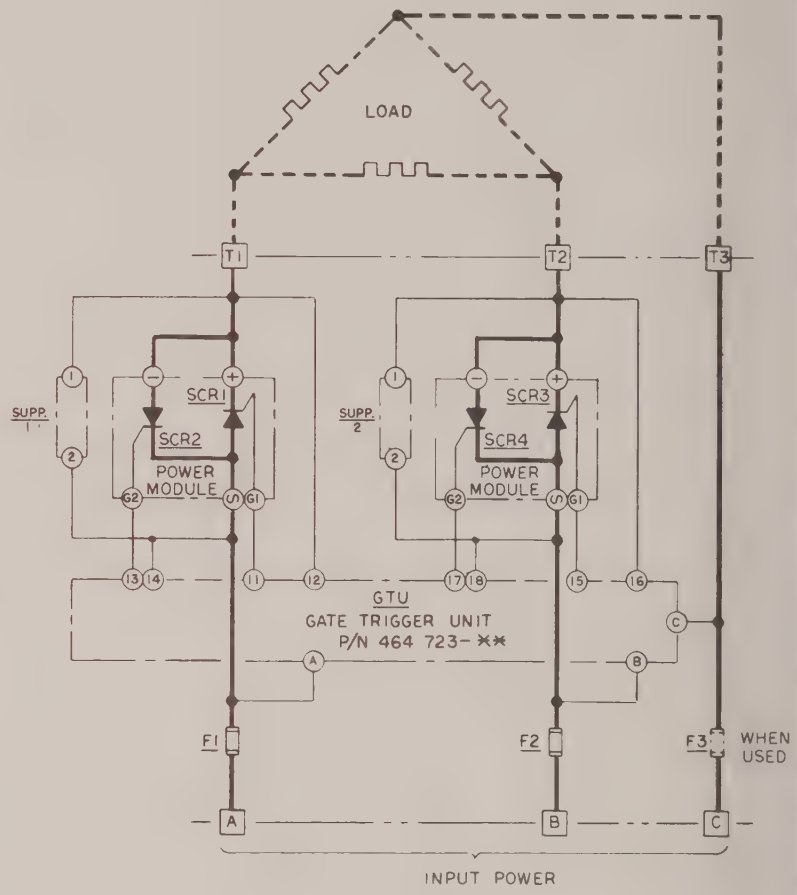
CONT SHEET	SHEET NO	DWG NO	REV
4	3	444 300	A

REVISIONS

DPTG CODE NO

VOLT/YR





NOTES:
1. TOP DIMENSION IS INCHES
2. BOTTOM DIMENSION IS CENTIMETERS
3. ** SEE CHART SHT. 1

FIG. 1, 2 25, 50A

SCALE 1/2 = 1	COLMAN Robicon Corporation A BARBER-COLMAN COMPANY	TITLE ZERO FIRED CONTROL OUTLINE, SCHEMATIC	
DATE 11-29-82		DWG NO 444 300	REVISION A
DRAWN RZ		CONT ON SHEET 4	SHEET NO 3
REVIEW			
CHECK	CUSTOMER 444 STD		
APPROVED 12/30/83	WORK ORDER STD	NO OF SHEETS 6	

FIG. 3
75 AMPS

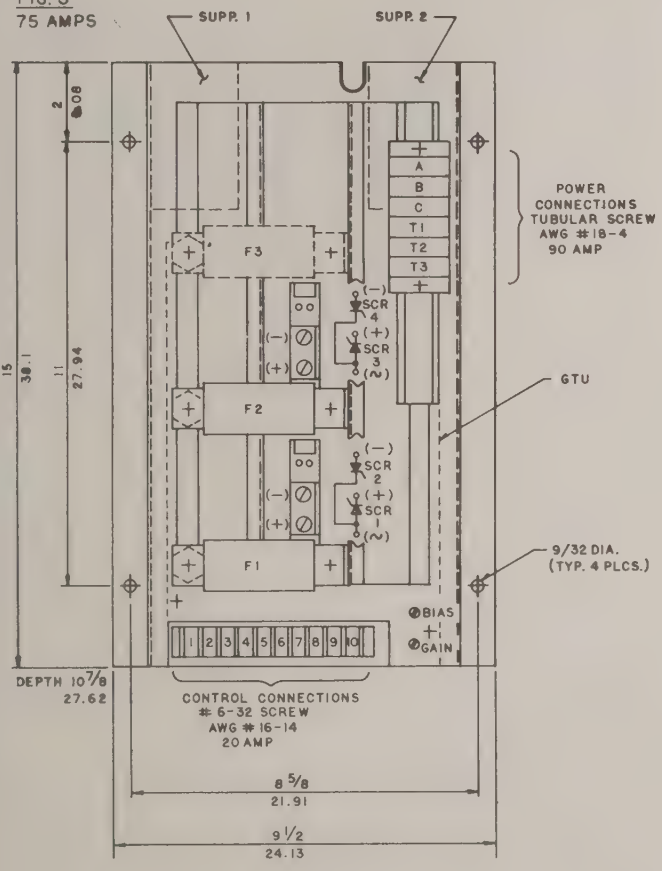
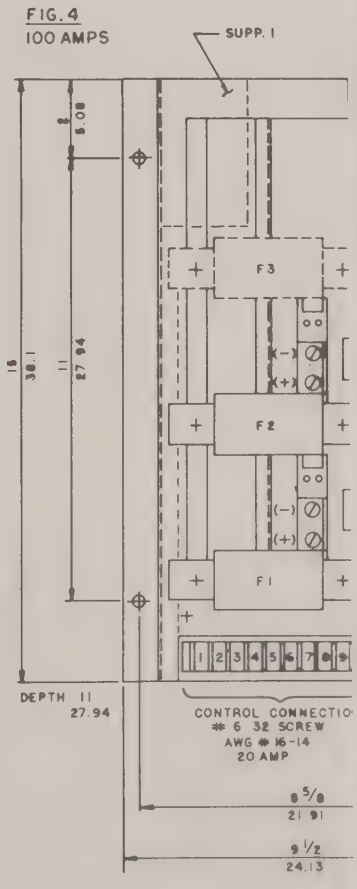
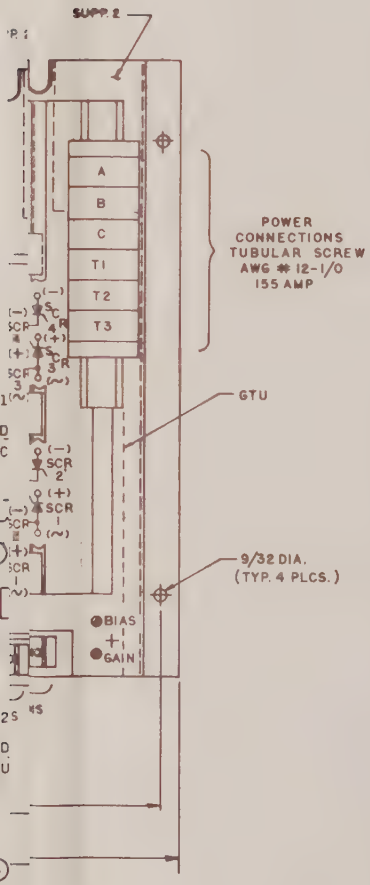


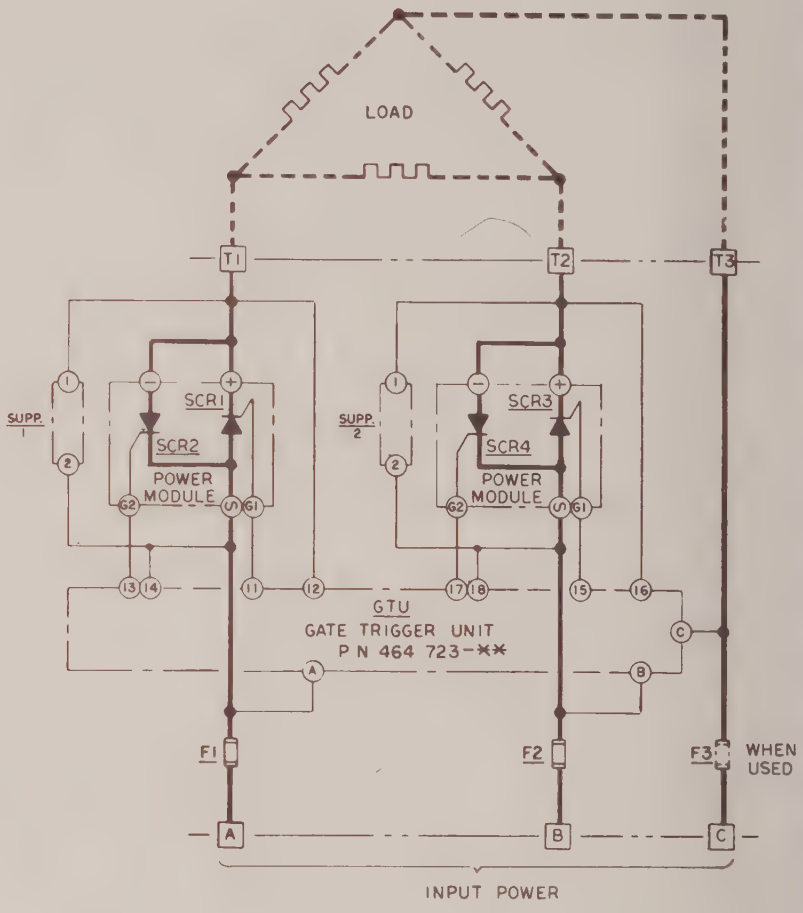
FIG. 4
100 AMPS



CONT. SHEET	5
SHEET NO.	4
DWG NO.	444 300
REV.	A

REVISIONS





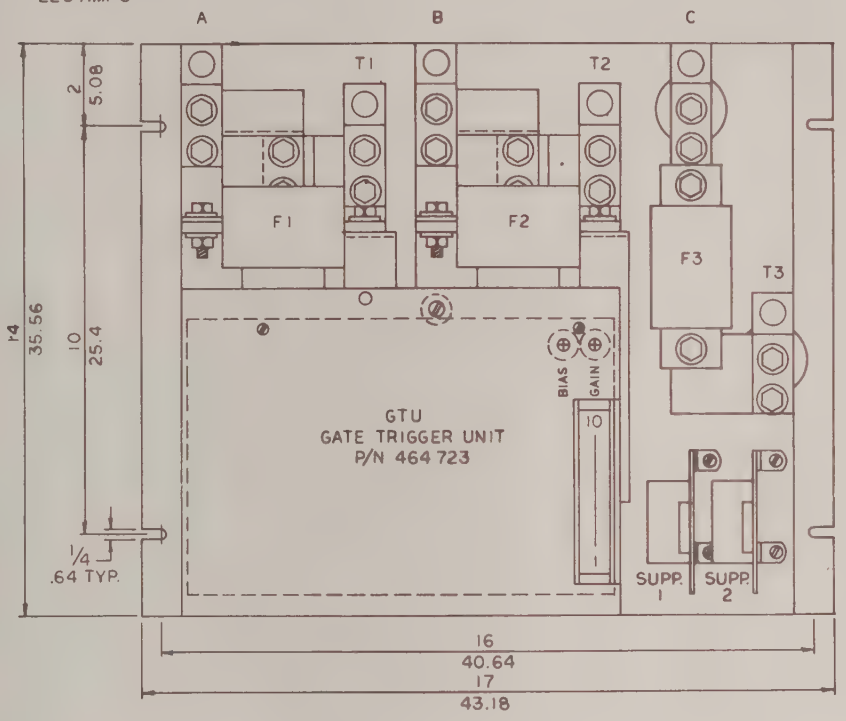
NOTES:

1. TOP DIMENSION IS INCHES
2. BOTTOM DIMENSION IS CENTIMETERS
3. **SEE CHART SHT 1

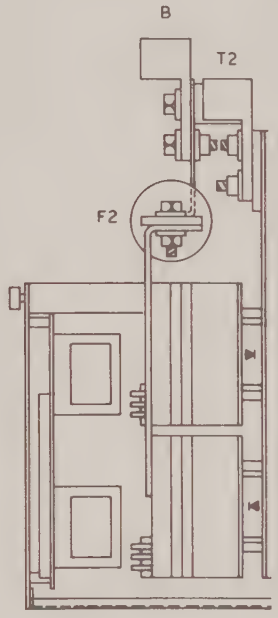
FIG. 3,4 75,100A

SCALE 1/2 = 1	COLMAC Robicon Corporation A BARBER COLMAN COMPANY	TITLE ZERO FIRED CONTROL OUTLINE, SCHEMATIC	
DATE 11-29-82		DWG NO 444 300	REVISION A
DRAWN RR		CONT ON SHEET 5	SHEET NO 4
REVIEW			
CHECK	CUSTOMER 444 STD		
APPD 12/8/82	WORK ORDER STD NO OF SHEETS 6		

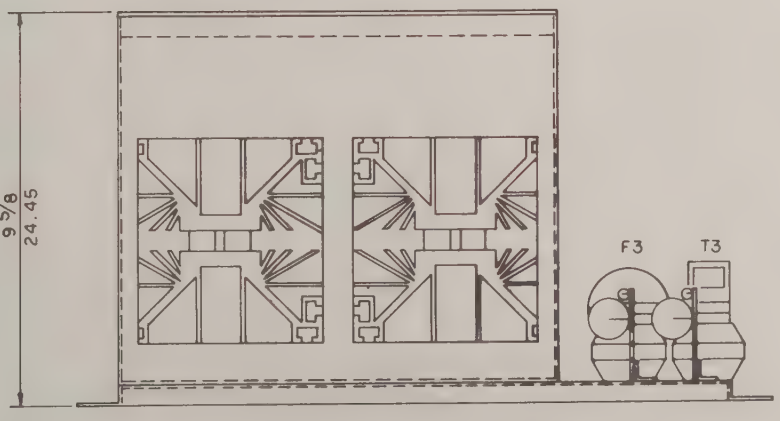
FIG. 5
160 AMPS
220 AMPS



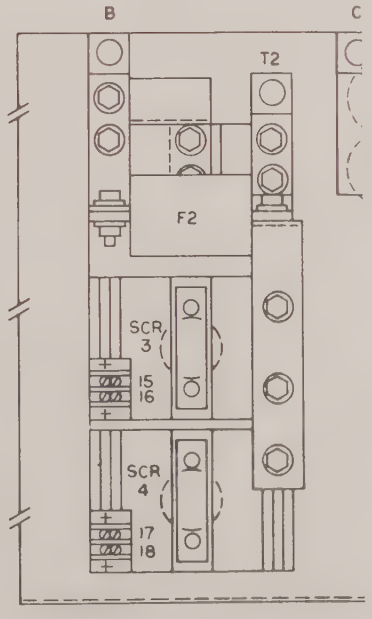
TOP VIEW
W/3RD LINE FUSE



SIDE VIEW



END VIEW

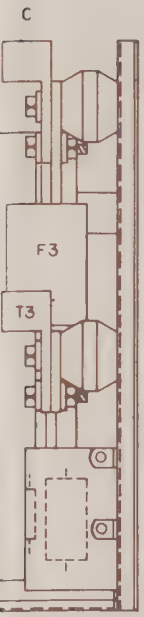


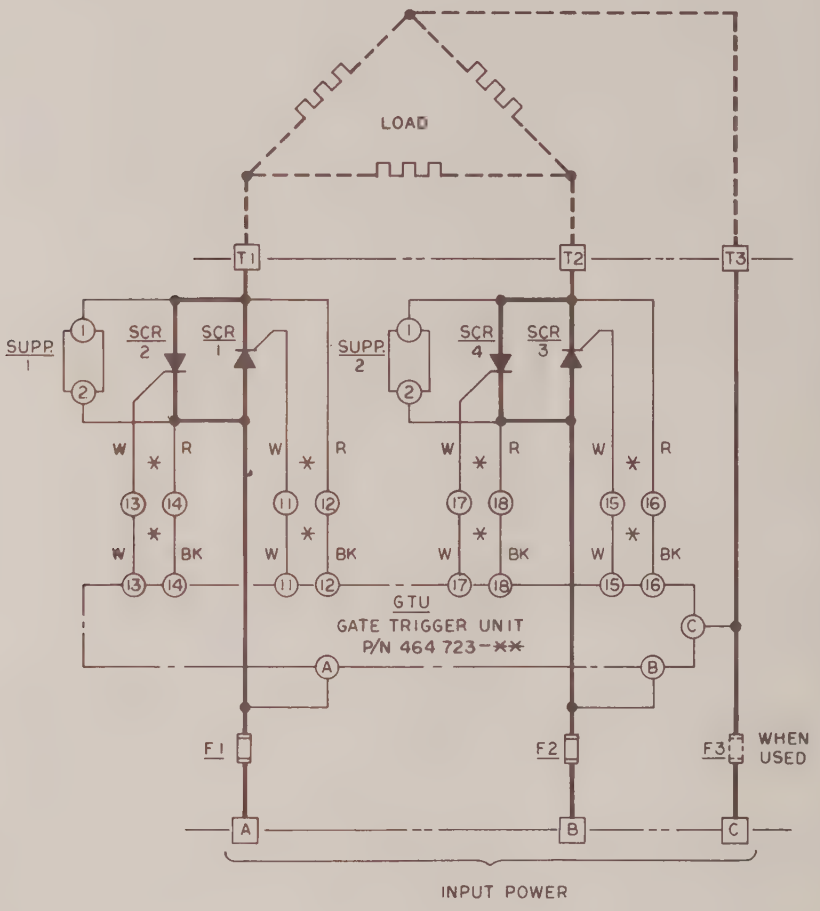
TOP VIEW
W/O 3RD LINE FUSE
W/O GATE BRD.

CONT. SHEET	6
SHEET NO.	5
DWG NO.	444 300
REV.	A

REVISIONS

MASTER DTG CODE NO.



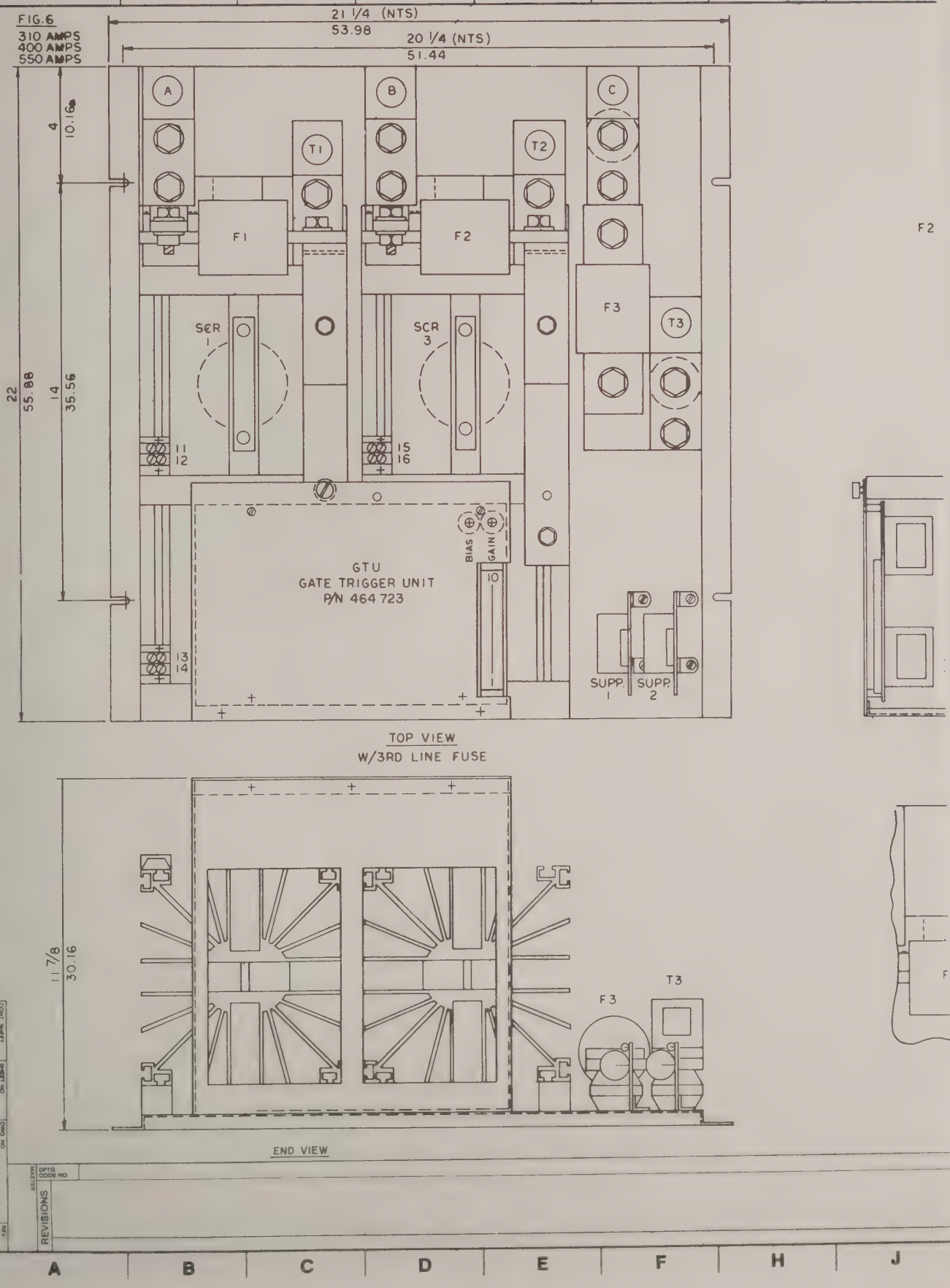


NOTES:
1. * DENOTES TWISTED PAIR.
2. TOP DIMENSION IS INCHES.
3. BOTTOM DIMENSION IS CENTIMETERS.
4. ** SEE CHART SHT. 1

FIG. 5 160, 220A

SCALE 1/2" = 1"	COLMAN	TITLE	
DATE 5/11/83	Robicon Corporation	ZERO FIRED CONTROL OUTLINE, SCHEMATIC	
DRAWN AB	A BARBER-COLMAN COMPANY	DWG NO 444 300	REVISION A
REVIEW	CUSTOMER	CONT ON SHEET 6	SHEET NO 5
CHECK	WORK ORDER STD	NO OF SHEETS 6	
APPROVED 8/26/83			

FIG.6
310 AMPS
400 AMPS
550 AMPS



TOP VIEW
W/3RD LINE FUSE

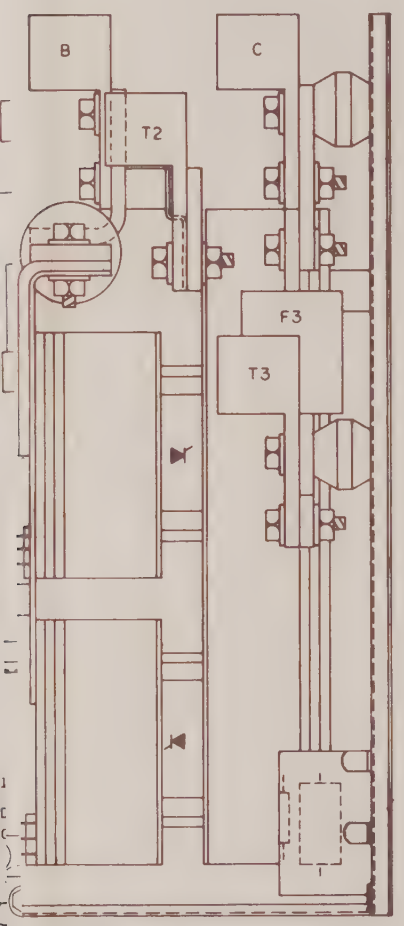
END VIEW

F2

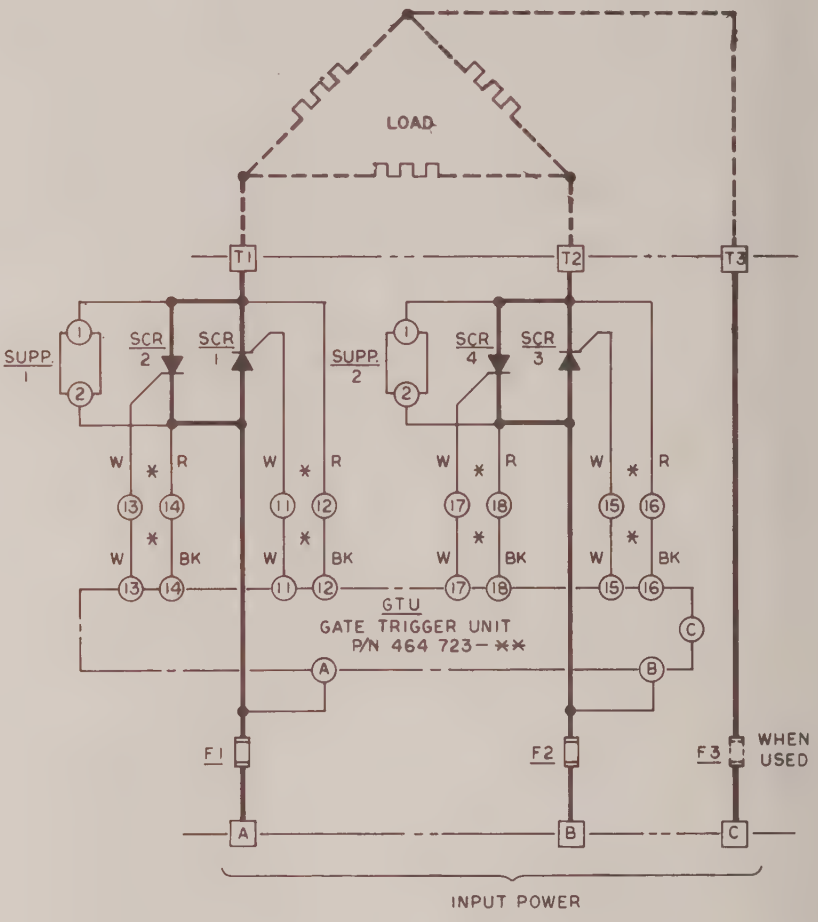
A	B	C	D	E	F	H	J

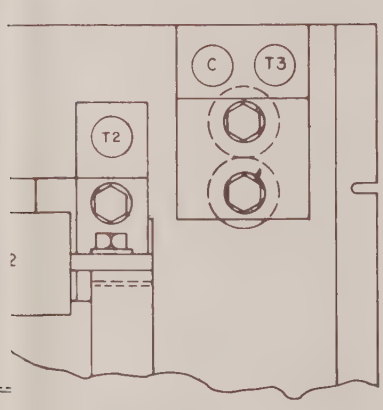
A	B	C	D	E	F	H	J

CONT SHEET	~		
SHEET NO	6		
DWG NO	444 300		
REV	A	REVISIONS	MASTER DTQ CODE NO



SIDE VIEW



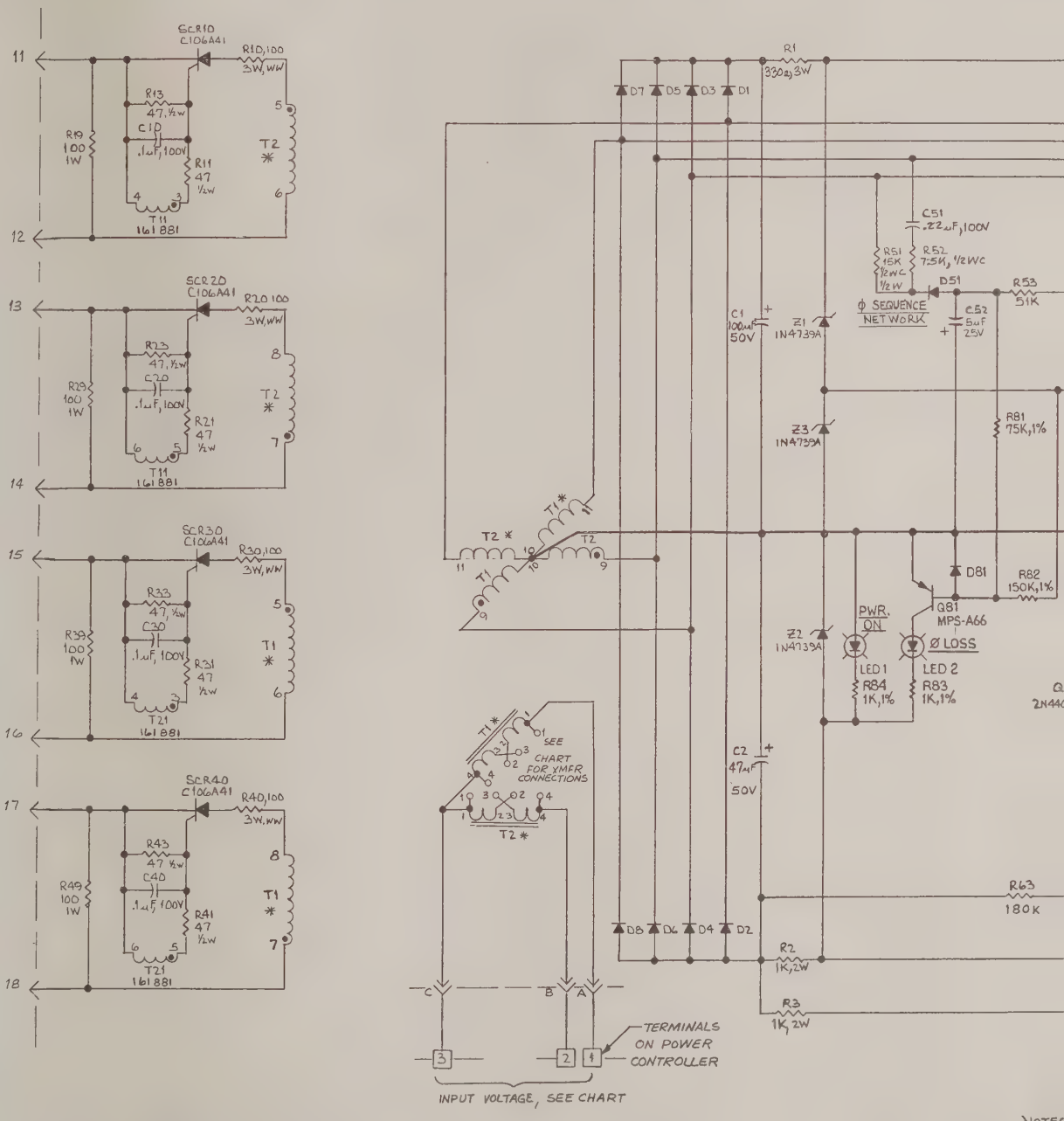


TOP VIEW
W/O 3RD LINE FUSE

NOTES:
1. * DENOTES TWISTED PAIR.
2. TOP DIMENSION IS INCHES.
3. BOTTOM DIMENSION IS CENTIMETERS.
4. ** SEE CHART SHT. 1

FIG.6 310,400,550A

SCALE 1/2" = 1"	COLMAN	TITLE ZERO FIRED CONTROL OUTLINE, SCHEMATIC	
DATE 5/18/83	Robicon Corporation A BARBER-COLMAN COMPANY	DWG NO 444 300	REVISION A
DRAWN AB		CONT ON SHEET ~	SHEET NO. 6
REVIEW			
CHECK	CUSTOMER		
APPROVED RDB 9/30/83	WORK ORDER STD / NO OF SHEETS 6		

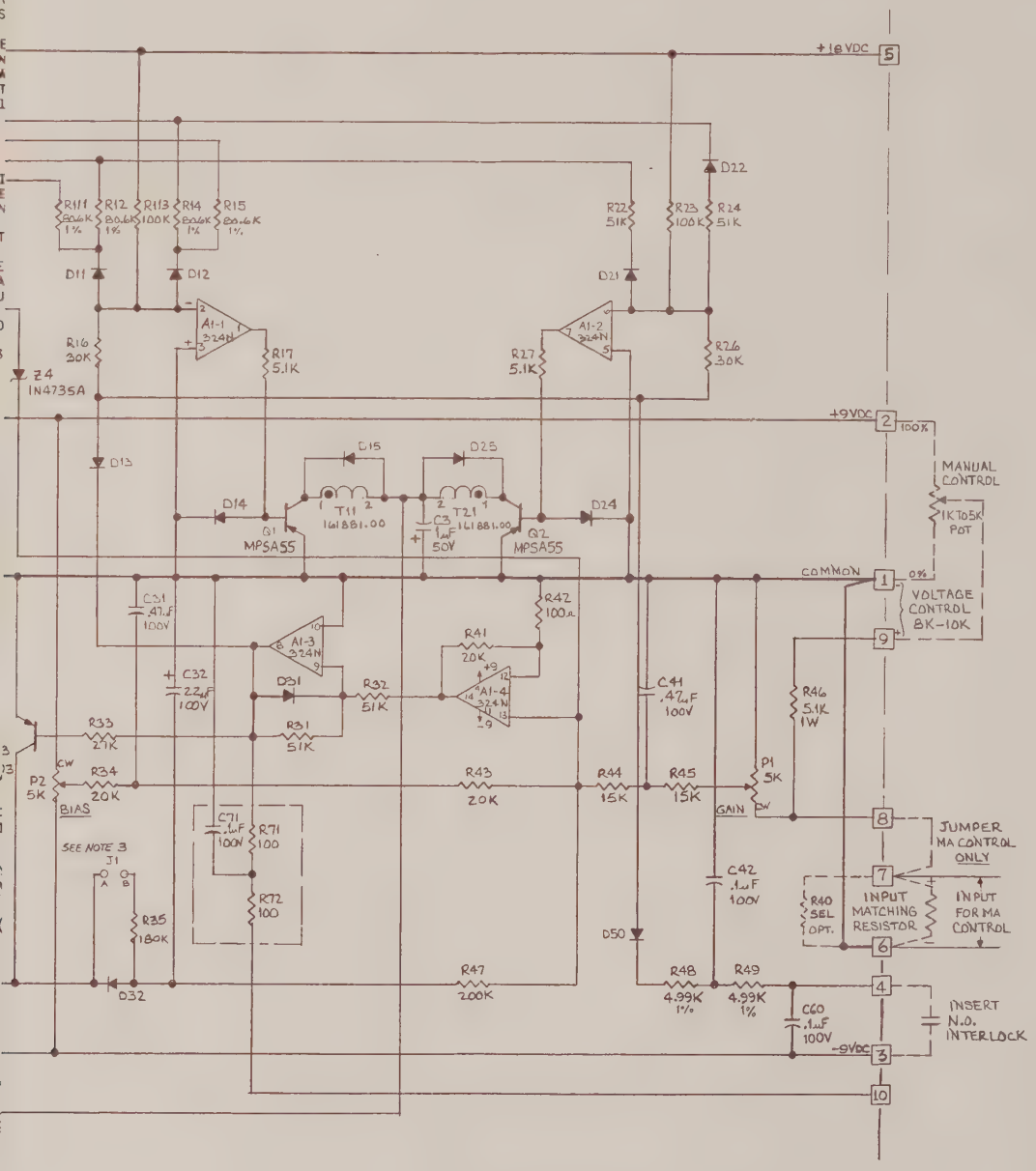


ROBICON PIN	INPUT VOLTS	* T1, T2 P/N	TERMINALS JUMPERED ON CIRCUIT BOARD FOR EACH XFMR T1,T2 AS SHOWN BELOW
464 723.01	208 VAC	161696.01	1 AND 3, 2 AND 4
464 723.02	240 VAC	161046.01	1 AND 3, 2 AND 4
464 723.03	380 VAC	161697.01	NOT REQUIRED-SINGLE PRIMARY WINDING
464 723.04	415 VAC	161696.01	2 AND 3
464 723.05	480 VAC	161046.01	2 AND 3
464 723.06	600 VAC	161698.01	NOT REQUIRED - SINGLE PRIMARY WINDING

NOTES
1.
2
3

CONT. SHEET —
SHEET NO. 1
DWG. NO. 475343
REV. G

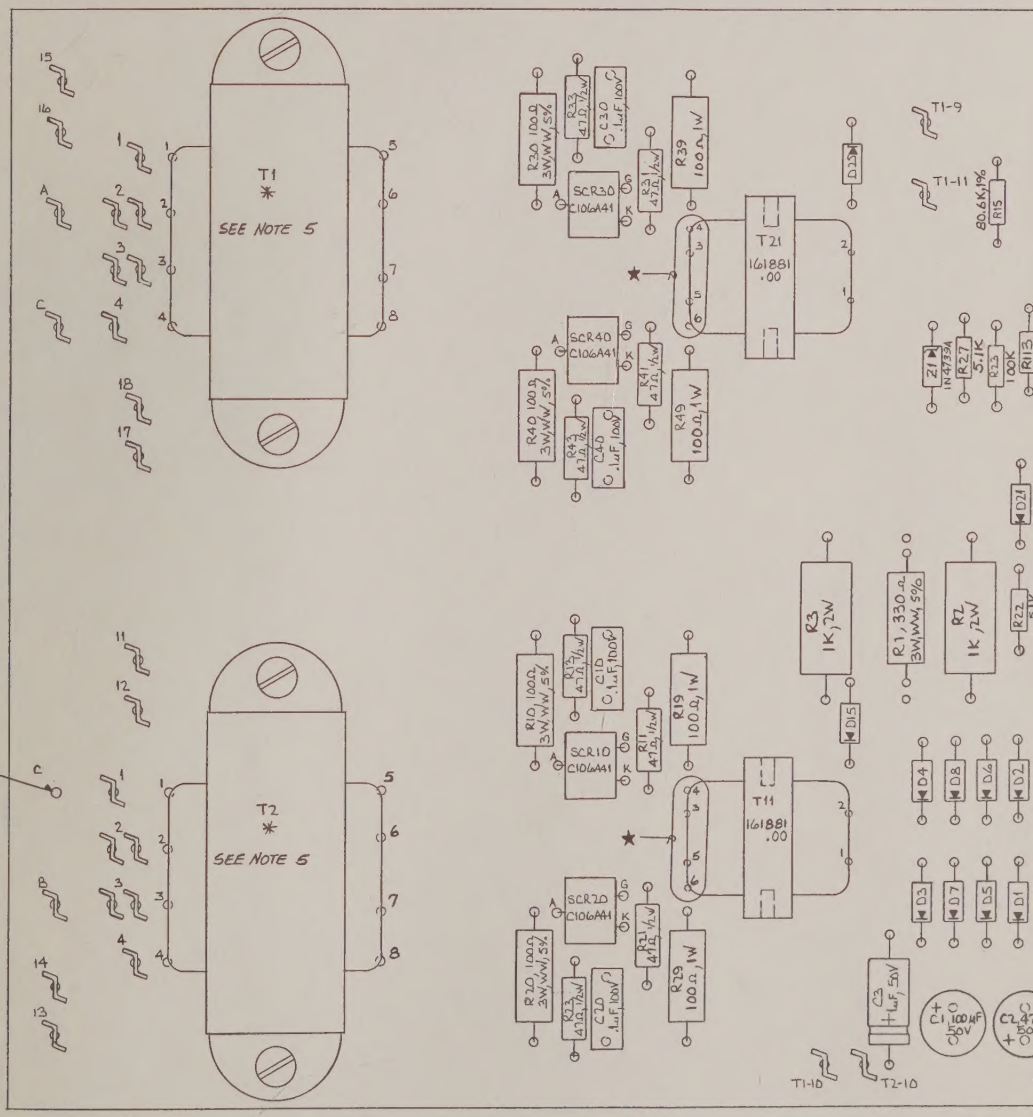
REVISIONS							
	A	B	C	D	E	F	G
		1309E	1329A		1357S		1370Z
		REVISED PER MARKED PRINT, R.O. 10/28/83 BLK	SPECIAL 208V PER R.O. 10 DWG RECORDS MEMO DTD 12-28-84	Alt. 3-21-85 ADDED WIRE BOARD NO.	R1 WAS 1K, 2W C1 WAS 47μF, 50V C2 WAS 100μF, 50V mfg STAMPS	ADDED R63, 180K 1%, R83, R84, 1K, 1% LED1, LED2, D51, D81 ADDED MOV, 1370Z H.B. 10/1/85	ADDED R81, 75K 1%, R82, 150K 1%



: UNLESS OTHERWISE SPECIFIED;
ALL DIODES IN4003.
. ALL 1% RESISTORS ARE MF, 1/4W, BANDED. OTHERS ARE 1/4W CARBON.
. JUMPER "J1" USED FOR AVERAGE FEEDBACK ONLY.

P.C. BRD 471102A

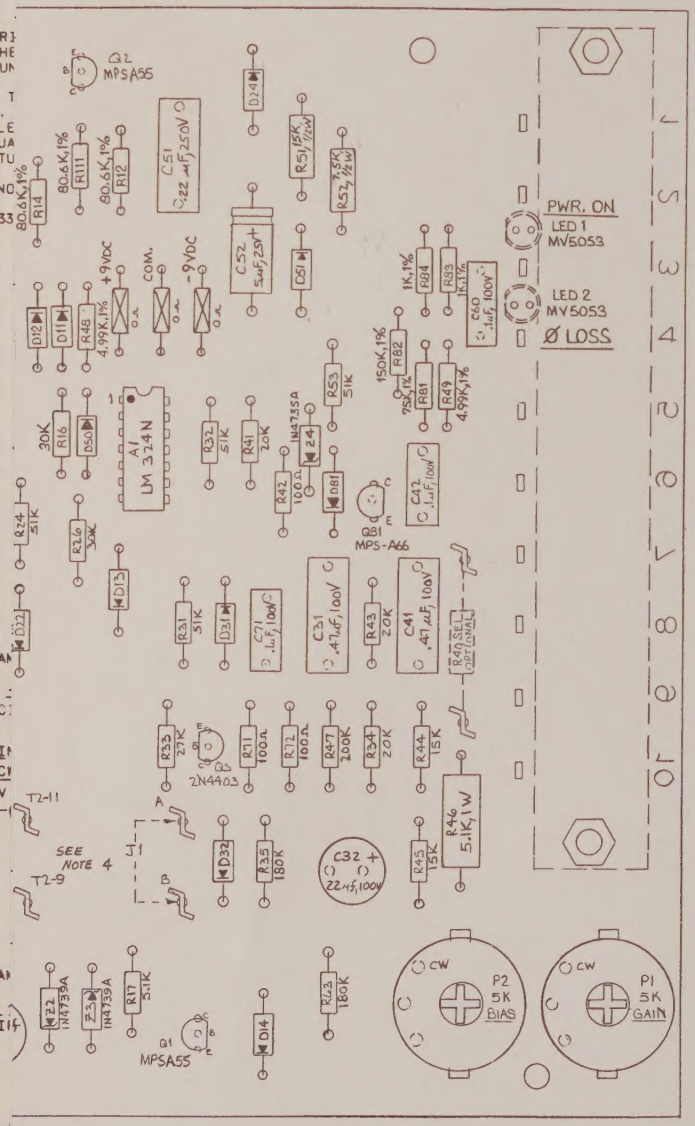
SCALE NONE	COLMAN COMPANY	TITLE	G.T.U 444 INDUSTRIAL SERIES (P/N 464723.01-06)
DATE JUNE 21, 1982	Robicon Corporation		
DRAWN L. Lutland	A BARBER-COLMAN COMPANY	DWG NO	475343
REVIEW	100 Sagamore Hill Road Penn Industrial Park Pittsburgh, PA 15239	REVISION	G
CHECK	CUSTOMER	CONT ON SHEET	—
APPROVE [illegible] 6/30/82	WORK ORDER / NO. OF SHEETS	SHEET NO	1



ROBICON P/N	INPUT VOLTS	*T1, T2 P/N	JUMPER TERMINALS ON CIRCUIT BOARD FOR EACH XFMR T1, T2 AS SHOWN BELOW
464 723.01	208V	161696.01	1 AND 3, 2 AND 4
464 723.02	240V	161046.01	1 AND 3, 2 AND 4
464 723.03	380V	161697.01	NOT REQUIRED-SINGLE PRIMARY WINDING
464 723.04	415V	161696.01	2 AND 3
464 723.05	480V	161046.01	2 AND 3
464 723.06	600V	161698.01	NOT REQUIRED-SINGLE PRIMARY WINDING

REVISIONS										
A	11037 - 22 MAR 1984 ADDED 464 723.04, 464 723.05, AND 464 723.06 APV'D:									
B	REVISED PER MARKED PRINT R.O. 10/28/83									
C	12137 - 23 APR 1984 ADDED "DO NOT PUT AMP. TERM. IN THIS HOLE" APV'D:									
D	11236 C31 WAS 1000μF 50V APV'D:									
E	SHT 2 - ADDED FOR MFGR USE ONLY M.G.J 6-28-84									
F	13098 - 2 DEC 1985 Q1 & Q2 WERE 2N-4403 APV'D:									
G	C1 WAS 47μF @ 50V C2 WAS 100μF @ 50V R1 WAS 1K, 2W M.G.J 5/6/85 (1329A)									
H	13515 ADDED D19, D20 & 2 JUMPERS FOR 4 HOLE HEADER 24 AWG #20 JUMPERS D.M.D. 5/15/86									
J	13702 ADDED LED 1 (1200) R81, R82, R83 AND R84, D81 & Q81, H.B. 10/16/86 D.M.D. 11/5/86									

MASTER	CONT SHT: 2	SHT NO: 1	DWG NO: 464723	REV: J



RSIDE OF T11 & T21 WITH CLEAR RTV

NOTES: UNLESS OTHERWISE SPECIFIED;

1. ALL DIODES IN4003.
2. ALL 1% RESISTOR ARE MF, 1/4W, BANDED.
3. UNMARKED RESISTORS ARE 1/4W CARBON.
4. JUMPER "J1" USED FOR AVERAGE FEEDBACK ONLY.
5. WHEN T1 & T2 ARE P/N 161697.01 OR 161698.01 PRIMARY TERMINAL #4 BECOMES #2. ALSO TERMINAL #3 IS NOT ON TRANSFORMERS, SINCE THEY HAVE ONE PRIMARY WINDING. THEREFORE, TERMINAL #2 OF XFMR WILL BE PUT INTO HOLE #4 ON PW BOARD.
6. WHEN JUMPERS ARE REQUIRED FOR PRIMARIES OF T1 & T2 USE # 22 AWG. 261052.30 WITH CRIMP TERMINALS P/N 640 955-2 .

REF. DWG.: PC DWG. 461102, PC BRD. 471102A, SCHEM. 475343

SCALE	2" = 1"
DATE	JUNE 29 1982
DRAWN	C. Gabbard
REVIEW	
CHECK	
APPROVED	KCB 6/30/82

ROBICON CORP.
PITTSBURGH, PA.

CUSTOMER
WORK ORDER

TITLE: G.T.U. 444 INDUSTRIAL SERIES — COMPONENT ASS'Y

DWG. NO. 464 723 | REVISION J

CONT. ON SHT. — | SHT. NO. 1

MP MASTER
MA32117